경영학석사학위논문

The Impact of Technological Complementarity on Post-Acquisition Innovation Performance

: The Moderating Effect of National Cultural Distance

기술 보완성이 인수 후 혁신 성과에 미치는 영향에 관한 연구

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이 논문을 경영학석사학위논문으로 제출함

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Abstract

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This study investigated how technology complementarity influences the post-acquisition innovation performance in cross-border technological acquisitions. It is argued that acquiring complementary technology will have a positive impact on the acquirer's post-acquisition innovation performance. Furthermore, as it is suggested that knowledge transfer and integration is influenced by cultural distance, this study also examined how national cultural distance moderates the relationship between technology complementarity and innovation performance. The results show that national cultural distance weakens the positive relationship between complementary technology and innovation performance, using data of 191 cross-border technology acquisitions from 1985 to 1995. The study suggests that managers should take technology complementarity and cultural distance into consideration when implementing acquisitions.

Keywords: technology complementarity, innovation performance, technological acquisition, cultural distance, cross-border acquisition

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Contents

1. Introduction

In high-tech industries, technological change is rapid and frequent (Sarkar et al., 2006). As a result, the ability to develop innovation products in quick succession is critical in the turbulent and continuously changing environment (Brown & Eisenhardt, 1997). However, the process of internally developing technological and innovative capabilities is time-consuming, path-dependent and uncertain (Dierickx & Cool, 1989). To overcome the time compression diseconomies, firms are increasingly turning to external source of innovation such as technological acquisition to generate innovation. Technologically rich acquisition targets provide opportunities for organizational learning by exposing the acquirer to new and diverse knowledge (Ghoshal, 1987; Hitt et al., 1996). Technology acquisitions enhance firm's ability to react adequately to changing circumstances. They also enrich the knowledge bases and break the rigidity of acquiring firms.

While the majority of M&As involve two firms within the same country, over 40% of the M&As that were completed in 1990s involved firms headquartered in two different countries (Hitt et al., 2001a,b). Herein, we define cross-border M&As as those involving an acquirer firm and a target firm whose headquarters are located in different home countries. In the organizational learning perspective, cross-border acquisitions provide a mechanism for accessing valuable routines and repertoires that are missing in its own national culture without having to follow the development path that

leads to them (Jemison and Sitkin, 1986). This presents an especially good opportunity for the acquiring firm to expand the knowledge base of the firm, which has the potential to enhance the combined firm's competitive advantage and performance over time (Jemison and Sitkin, 1986). At the same time, cross-border M&As are an important source of new information and capabilities, which provide strategic flexibility for acquiring firms.

However, acquisitions are often associated with implementation problems and unsatisfactory post-acquisition performance. Ravenscraft and Scherer (1989) found that, on the average, the profitability of target firms declines after their acquisitions. Cartwright and Cooper (1993) note that at best, merely half of all M&As meet initial financial expectations, with failure rates in the 50 to 60 percent range.

As a good case in point, Lenovo acquired the PC business of IBM in 2004, however, the acquisition was reported not to be a failure, for Lenovo repeatedly failed successfully to launch consumer PCs outside China. And Lenovo was also slow in entering netbooks, and it fell behind Acer, its Taiwanese rival. TCL's M&A of TV business of Thomson provides another example for failed cross-border M&A. As China's largest color TV and second largest mobile phone maker, TCL began to aggressively promote its brand internationally in 2000 (Deng, 2009). Its global expansion culminated in January 2004 when it struck a $560 million deal of merging its TV and DVD operations with those of French consumer electronics giant Thomson. Unfortunately, the deal is now widely regarded as a typical example of Chinese company that "failed miserably in overseas expansion"

(Economist.com, 2007). Due to its highly problematic and value-destroying European operations, during the two years of 2005-2006, TCL cumulatively suffered a total loss of RMB 5.07 billion ($680 million). As a result, in November 2007, TCL declared its European operation "insolvent" and overhauled its TV manufacturing operations.

Acquiring and absorbing an existing organization may be a difficult, and sometimes painful process. The integration process often leads to clashes and tensions, owning to the confrontation of different cultures, structures and systems (Chatterjee et al., 1992; Datta, 1991; Jones & Hill, 1988). Cross-border M&As pose tremendous challenges, in particular, at the post acquisition stage (Child et al., 2001). While lack of cultural fit has been frequently mentioned as a potential factor in M&As failures (eg. Nahavandi & Malekzadeh, 1988; Weber and Schweiger, 1992), a study by KPMG found approximately that only 17% of cross-border acquisitions created shareholder value, while 53% destroyed it (Economist, 1999).

Given the increasing number of cross-border M&As and their growing importance in the global market, a better understanding of the opportunities and challenges for firms following this strategy is required. In this paper, we examine the impact of technological complementarity on the subsequent innovation performance of acquiring firms. Especially, the interplay between technology complementarity and national cultural distance is emphasized. Based on recent debates on the effect of technology relatedness on a firm's innovation performance (e.g. Colombo & Rabbiosi, 2014; Larsson & Finkelstein, 1999; Makri et al., 2010; Puranam et al., 2006; etc.), this study is

developed to show the positive impact of technology complementarity on acquiring firm's post-M&A innovation performance. Furthermore, national cultural difference is expected to increase the knowledge integration cost, thus, negatively moderate the relationship between technological complementarity and post-M&A innovation performance. These arguments were tested using 191 cross-border technology acquisitions. Supporting these arguments, we find that technology complementarity positively influences post acquisition innovation performance, and national cultural distance weakens the positive relationship. This study contributes to the literature on post acquisition performance by providing supportive empirical evidences for the impact of technology complementarity on post acquisition innovation performance. This study also shed light on the interplay between technology complementarity and national cultural distance, which is not studied in the previous literature.

2. Literature Review

2.1 Cultural distance & cross-border M&A

Previous literature reported that the effect of cross-border M&As on a firm's innovation performance is different from the domestic ones. Some argued that firms are motived to conduct cross-border M&As in order to seek diverse technology existing outside the host country (Patel and Pavitt, 1997). Bertrand and Zuniga (2006) pointed out that, technological resource heterogeneity among merging firms in different geographic locations brings a

stronger synergy effect. These studies show that firms conduct cross-border M&As to acquire new technological resources which are not existing in the domestic R&D knowledge sets previously. Furthermore, as argued by previous researches that firm's incentive to innovate may be reduced because of the decrease in R&D competition resulting from domestic M&As, competing effect is not seen in cross-border M&As (Bertrand & Zuniga, 2006; Reinganum, 1983). Competition between firms tend to be more fierce if two firms are located in the same geographical market rather than in different locations. In conclusion, cross-border M&A provides opportunities to seek and explore diverse knowledge which is not easily found within domestic countries.

However, knowledge transfer across different countries may incur great challenges and increase integration costs between the acquiring and target firms (Bertrand & Zuniga, 2006; Kogut & Zander, 1992; Javidan, Stahl, Brodbeck,& Wilderom, 2005). Some studies have shown that high-tech firms do not prefer international diversification, since when cultural distance getting larger, the risk of investing in technologies also increases (Tihanyi, Griffith, and Russell, 2005). It is also argued that misunderstanding happens between employees from diverse cultural backgrounds, which influence the knowledge transfer process negatively (Ambos and Ambos, 2009). It is also reported that organizational differences among merged firms negatively influence their innovation output (Kapoor and Lim, 2007).

In cross-border acquisitions, many studies suggested that organization friction is created in consequence of the cultural difference between the acquiring and target firms, which eventually harm the post-acquisition output

(Stahl and Voigt, 2008). What's more, empirical evidence shows that the greater the cultural distance between the acquirer and the target firms, the less the shareholder's wealth in the acquiring firm becomes (Datta & Puia, 1995). In knowledge-seeking acquisitions, uncertainty caused by cultural differences makes it difficult to acquire technological knowledge from the target firms (Pothukuchi, Damanpour, Choi, Chen, & Park, 2002). On the other hand, other studies have found that organization coordination is necessary to exploit the strategic resources possessed by merged firms, organizational fit contributes positively to synergy realization (Larsson & Finkelstein, 1999).

2.2 Technology complementarity and innovation

Technological acquisitions are acquisitions that provide technological inputs to the acquiring firm. Thus, they potentially expand the acquirer's knowledge base and provide scale, scope, and recombination benefits (Henderson and Cockburn, 1996; Fleming, 1999). However, technological acquisitions can also entail a disruption in organizational routines, especially in the innovation arena. On balance, assessing whether technological acquisitions will have a positive or negative impact on post acquisition innovation output is likely to depend upon the quantity and nature of technological elements that they bring to the acquiring firm.

Research on high-technology M&As has identified the relatedness of the buyer's and the target's technological knowledge as an important predictor of post-merger innovation performance (Cloodt, Hagedoorn, and Van

Kranenburg, 2006; Cassiman et al., 2005; Hagedoorn and Duysters, 2002). The positive effect on innovation is, in part, based on absorptive capacity; the more similar the two firms' technological knowledge, the more quickly the acquired firm's knowledge can be assimilated and commercially exploited (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). However, too much similarity reduces the acquirer's opportunities for learning (Ghoshal, 1987; Hitt et al., 1996), since that integrate highly similar technologies narrow the range of potential learning and also reduce the incentives to explore divergent research opportunities available from M&As. In short, M&As improve innovation performance the most when the acquired technological knowledge is similar enough to facilitate learning, but different enough to provide both opportunities and incentives to explore new search scope.

While complementarity seems to be a crucial concept in a strategic theory of the firm, it is seldom clearly defined. (Stieglitz & Heine, 2007) In economics literature, Milgrom & Robers (1995) defined assets and activities are mutually complementary if the marginal return of an activity increases in the level of the other activeiy. It is argued that complementarity gives rise to 'synergy' among the complementary activities, with the total being more than the sum of the parts. In strategy literature, complementarity was discussed using the resourced-based view that complementarity arises when a combination of resources or capabilities that are different but mutually reinforcing enables a firm to create value that it cannot create withou such a combination. (Helfat&Peteraf, 2003) Larsson&Finkelstein (1999) defined synergistic complementarities as 'different products, market access, or knowhow that fit with and enhance one another'. Complementarities have been found to be key

success factors in qualitative studies of M&As (Hitt et al. 1993). They argued that synergies can be achieved through "economies of fitness" (from combining different, but complementary, operations). Tanriverdi&Venkaraman (2005) defined complementary resources as ‘not identical, but interdependent and mutually supportive’. The returns obtained from the joint adoption of complementary resources are greater than the sum of returns obtained from the adoption of individual resources in isolation. Wang & Zajac (2007) followed this defination, and defined business complementarity as the extent to which two firms' resources are different, yet interdependent and mutually supportive.

Makri et. Al (2010) defined technology complementarity between firms as ‘the degree to which their technological problem solving focuses on different narrowly defined areas of knowledge within a broadly defined area of knowledge that they share’. The definitions of science and technology complementarity refer to knowledge complementarities within a value chain activity (R&D) as opposed to asset complementarities across different value chain activities. While synergies can arise from knowledge relatedness at multiple points of the value chain (Tanriverdi and Venkatraman, 2005), because invention is critical for the success of high-technology firms, it is important to assess knowledge relatedness within R&D. Therefore, focusing on knowledge relatedness in one dimension of the value chain (R&D) provides for a richer and more complete specification of this construct and permits us to directly measure knowledge relatedness at the firm level. Further, limiting the definition of complementarity in this domain facilitates the empirical analysis. Yet, it also supports the broader definition of complementarity in

economics in which combining one input with another increases the marginal returns from that input (Milgrom and Roberts, 1990, 1995). Additionally, because science and technology are 'dancing partners' (Rip, 1992), enriching a firm's science knowledge domain can enhance its technology domain. As such, complementarity used herein implies integration potential. This study followed the defination of technology complementarity defined by Makri et. Al (2010).

3. Hypotheses

Technological complementarities facilitate a process of exploration with new competencies and technologies (March, 1991). Technological complementarity between firms is the degree to which their technological problem solving focuses on different narrowly defined areas of knowledge within a broadly defined area of knowledge that they share. For firms that rely on continuous innovations as a source of competitive advantage, technological knowledge synergies have become increasingly critical. Cassiman et al. (2005) found that when the merged entities are technologically complementary, their R&D productivity increases. Yet, more research is needed to address the effects of technological complementarities on innovation outcomes.

Acquiring complementary technologies helps extend the scope of innovation search, which in turn contributes to richer innovations. However, integrating complementary technologies may also increase coordination cost, for it requires significant effort because it is more complex and challenging than

integrating similar knowledge domains (Grant, 1996). Yet, when the acquiring and acquired firms have technological complementarities, they have common knowledge stocks (in broadly defined areas) that facilitate communication and coordination between the units from the two firms after the acquisition. Also, the common knowledge in broad areas helps each party understand the value of the unique but complementary sets of technological knowledge. These conditions facilitate the integration of their two complementary knowledge stocks in the firm, thereby contributing to increased innovation performance. Rothaermel, Hitt, and Jobe (2006) found firms that are able to integrate complementary knowledge from internal and external sources increased the number of related new products introduced to the market. High knowledge complementarities between the acquiring and acquired firms enhance the firm's ability to use new information in effective ways. In this way, technological complementarity increases the probability of success in R&D processes (Cyert and March, 1963).

In addition, technological complementarities also affect the novelty and quality of a firm's innovation performance (Hall, Jaffe, and Trajtenberg, 2001, DeCarolis and Deeds, 1999; Rosenkopf and Nerkar, 2001). The theory of recombinant invention (Fleming, 2001) suggests that the merger of two firms can potentially lead to the creation of high-quality inventions when they have similarities in their knowledge bases but also when some fraction of their knowledge is fairly diverse to permit effective, creative utilization of the new knowledge (Cohen and Levinthal, 1990: 136). Similar activities in R&D activities conducted by the acquiring and acquired firms that share broadly defined areas of technological knowledge allow them to communicate,

coordinate, and cooperate in effective ways. Yet, their focus on different specific knowledge areas of technology allows the merged firm to use the complementary technology in ways that increase the merged firm's exploration search processes. Exposure to new sets of routines, new modes of reasoning, and challenges to existing understandings helps a firm discover novel solutions to problems it has identified.

The integration of these complementary technology stocks can produce unique combinations and, thus more innovations. Moreover, integrating complementary technologies provides the potential for a much greater portfolio of new and unique technological combinations. Thus, technological complementarities contribute positively to post acquisition innovation performance. These arguments lead to the following hypothesis:

H1: The greater the technological complementarity between acquiring and target firms, the higher the level of post-acquisition innovative performance.

As technological complementarity expands a firm's knowledge base, the technological knowledge integration and organizational coordination costs also increase (Katila and Ahuja, 2002). Technologically, common interfaces need to be established among knowledge elements. Organizationally, new knowledge requires changes in networks of relations and communication relationships within the organization (Henderson & Clark, 1990). We argue that greater national cultural distance increases the knowledge integration and organizational coordination cost, which eventually, influences the relationship between technological complementarity and innovative performance.

Adler and Jelinek (1986) suggested that "culture, whether organizational or

national, is frequently defined as a set of taken-for granted assumptions, expectations or rules for being in the world," and that "the culture concept emphasizes the shared cognitive approaches to reality that distinguish a given group from others." Hofstede (1980) defined national culture as the collective programming of the human mind. National cultural distance can be defined as the extent to which the shared norms and values in one country differ from those in another (cf. Hofstede, 2001; Kogut & Singh, 1988; Morosini et al., 1998).

According to the knowledge-based theory of the firm, firms exist as institutions that integrating the knowledge of many different individuals in the process of producing goods and services (Grant, 1996). And the fundamental task of an organization is to coordinate the efforts of many specialists. In organization science, it is argued that coordination of complementary resources increase the complexity of decisions since more variables have to be observed and taken account of (Thompson 1967; Simon, 1967). When it comes to acquisitions, the coordinating problem is deepened as two different parties getting involved in the knowledge integration process. Achieving effective coordination is especially challenging for the newly merged organization. If technological resources provided by the acquisition are complementary, the need for some kind of coordination is apparent, since the added value of one resource depends on the use of other resources and their individual deployment has to be consistent. As a result, integrating complementary technology can require significant effort because it is more complex and challenging than integrating similar knowledge domains (Grant, 1996). While most explicit knowledge and all tacit knowledge is stored within

individuals, much of this knowledge is created within the firm and is firm specific. Explicit knowledge acquired through technology acquisition can be revealed by its communication. And tacit knowledge that cannot be codified will only be observed through its application and acquired through practice. This makes its transfer between the acquiring and target firms to be slow, costly, and uncertain (Kogut & Zander, 1992).

According to institutional theory, organizations are influenced by the societies in which they operate (Granovetter, 1985). The institutional environment of a firm and the historical path development of the routines appear to be embedded in national culture (Barney, 1986). It is shown that firms from culturally dissimilar countries have different organizational practices (Child, Faulkner, & Pitkethly, 2001; Kogut & Singh, 1988), different routines and repertories for organizational learning, and other different aspects of management (Kogut and Singh, 1988). Extensive empirical research has shown that, on average, the greater the national cultural distance between two countries, the more dissimilar and incompatible their practices (Kogut & Singh, 1988). Especially, routines and repertoires related to innovation and inventiveness have been found to vary significantly across countries (Shane, 1993; McGrath et al., 1992).

If most of the knowledge relevant to the acquired complementary technologies is tacit, then the transfer will be particularly difficult in a culturally distant acquisition. Grant (1996) argues that the existence of common language and similar communication system facilitate coordinated activities, such as the conversion of tacit knowledge into explicit form, which eventually improve the

integration of the knowledge between the two parties. However, it is shown that firms from culturally dissimilar countries have different communication systems, different organizational practices (Child, Faulkner, & Pitkethly, 2001; Kogut & Singh, 1988), different routines and repertories for organizational learning, (Kogut and Singh, 1988). On consequence of this, foreign language problems, miscommunication and misunderstanding caused by different national culture in a culturally distant acquisition will impede smooth interaction between technology specialists, which complexes the mechanisms through which individuals integrate their productive activities. As a result, greater national cultural distance largely increases the integration cost of complementary technological knowledge and makes it difficult to learn from the acquisition.

On the other hand, Grant (1996) also points out that shared understanding and similar organizational routines facilitate human interaction, which in turn improve the efficiency in achieving coordination. The higher the level of shared understanding, the more efficient is integration likely to be. However, many empirical studies have shown that, on average, the greater the national cultural distance between two countries, the lower the level of their shared understanding (Kogut & Singh, 1988). As a result, the employees involved in a culturally distant acquisition experience very low level of shared understanding and quite different organizational routines. These problems impede the potential knowledge transfer, diffusion, and integration. On consequence of this, greater national cultural distance increases the coordination cost significantly. And these arguments lead to the following hypothesis:

H2: The greater the level of national cultural distance, the weaker the positive relationship between technological complementarity and the post acquisition innovation performance.

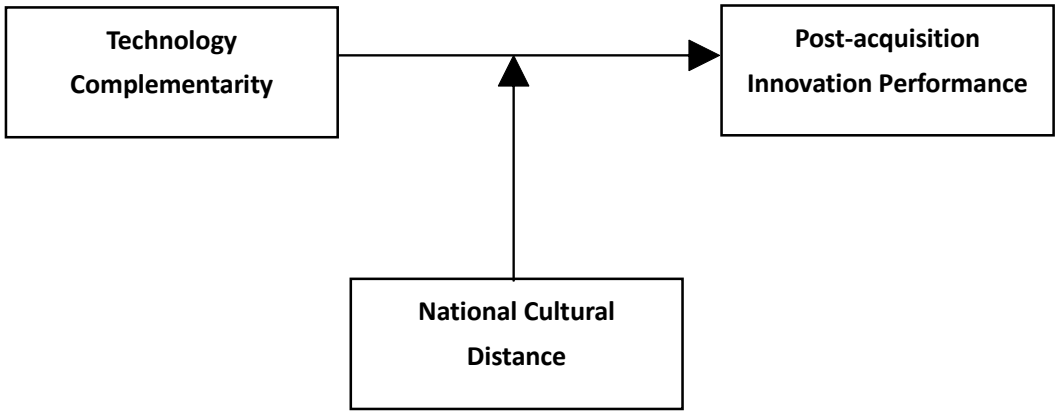

Figure1. Research Model

4. Methodology

4.1 Sample

The hypotheses were tested using 191 cross-border technology acquisitions implemented by global companies in high-technology industries during 1982 to 1994. This specific period was selected because that cross-border M&As increased rapidly since late 1980s to the late 1990s (Bertrand & Zuniga, 2006). And the limited access to more recent patent data from the National Bureau of Economic Research (NBER) patent database constrained the empirical analysis on the most up-to-date M&A cases. Sample technology acquisition cases were retrieved from Securities Data Corporation database (SDC). And cases were selected from M&As in computer programming, telecommunications, medical and optical instrument, electronics, aerospace and defense, industrial materials, and drugs industries, as these industries are referred to as knowledge-intensive industries in that knowledge is the crucial source of innovation and competitive advantages of firms (Cloodt et al., 2006; Makri et al., 2010; Von Hippel, 1986). According to previous studies (Chatterjee & Lubatkin, 1990; Finkelstein &Haleblian, 2002), deals smaller than $10 million and larger than $500 million were excluded, as significantly small deals may have limited effect on post-acquisition performance, at the same time, too large acquisitions are more likely to have motivations other than knowledge seeking, such as market seeking.

As technological complementarity and innovation were measured by the patent

data, M&As in which case either an acquirer or a target does not have patents filed in the United States of Patent and Trademark Office (USPTO) were excluded. In addition, in order to distinguish between technological and non-technological acquisition, cases if the target does not have any patenting activities within the 5-year period prior to the M&A were dropped (Cloodt et al., 2006). These lead to the final 191 samples.

Measurements for the main variables of this study were created using the patent data retrieved from the NBER patent database. AS a patent's application year better represents firm's actual time of innovation than a grant year does (Griliches, Pakes, & Hall, 1988), number of patents were counted for which the firm applied pre- and post-M&A. The NBER data is beneficial especially in the context of M&A because the data is unaffected by the survivorship bias. Once the patent registration is granted by the USPTO, the ownership (i.e., the name of the assigned firm) of the patent belongs to the firm initially applied for even if the firm gets acquired or goes bankrupt.

Table 1. Sample Characteristics

Nationality of Acquirering Firms	Frequency	Percentage
Canada	8	4%
United Kingdom	59	31%
Japan	27	14%
Italy	7	4%
Sweden	11	6%
Germany	8	4%
United States	33	17%
France	15	8%
Netherlands	4	2%
Finland	4	2%
Denmark	1	1%
Norway	1	1%
Israel	5	3%
Spain	1	1%
Switzerland	2	1%
Singapore	2	1%
Hong Kong	1	1%
Belgium	1	1%
South Korea	1	1%
Years of M&As		
1982	1	1%
1983	2	1%
1984	3	2%
1985	7	4%
1986	9	5%
1987	16	8%
1988	32	17%
1989	30	16%
1990	16	8%
1991	15	8%
1992	10	5%
1993	19	10%
1994	31	16%
Total	**191**	**100%**

4.2 Dependent variable

Firm's post-merger innovation performance was measured by capturing the change in firm's invention activity pre- and post-acquisition. The number of patents a firm holds has been extensively used to represent firm's inventive activity in innovation studies (Acs, Anselin, & Varga, 2002; Hitt, Hoskisson, Ireland, and Harisson, 1991; Makri et al., 2010; Pakes & Griliches, 1980). Patent count has been frequently suggested as a direct measure for invention productivity and innovation output (Hall, Jaffe, & Trajtenberg, 2001; Sorensen & Stuart, 2000). To construct this change measures, the number of patents for which the acquiring firm applied three years pre- and post-acquisition were counted, and then divided by the number of patents the acquiring firm had three years post the acquisition. This measure represents the degree of which the acquiring firm increased (or decreased) innovation output after it conducted the technology acquisition.

As it takes time for the impact of acquisition on innovation output to become effective, lagged measures for the dependent variable was utilized. In general, post-M&A performance is examined three to five years after the agreement takes place (Bettis & Mahajan, 1985). Following this convention, innovation output data for three to five years after the completion of the M&A was used. To compare and show the change of innovation performance, I also examined a three-year window prior to M&A and subtracted the performance measure from that of the post-M&A. By doing this, the effect of acquisition after the deal has been made would be accurately measured.

4.3 Independent variables

Technological complementarity was measured as the number of patents in the same subcategory but in different patent classes (Makri et al., 2010). It was operationalized as the number of patents applied for by the target and acquirer in the same patent subcategories subtracted by the number of patents sharing same patent classes, multiplied by the total number of patents the acquirer has in all common subcategories divided by total acquirer patents (Makri et al., 2010). This measure of technological complementarity entails theoretical conceptualization of complementarity because it represents similar yet heterogeneous features of technologies possessed by merging firms. This measure effectively captures the technological position of an acquiring firm relative to a target firm. USPTO categorized patents into 442 three-digit classes. Based on this classification, Hall et al. (2001) aggregated these 442 classes into 36 two-digit subcategories, and then combined those subcategories into 6 one-digit categories.

Technology complementarity is measured as follow:

$$\left(\frac{Overlap\ all\ patent\ subcategoreis}{Acquirer\&Target's\ total\ patents} - \frac{Overlap\ all\ patent\ classes}{Acquirer\&Target's\ total\ patents}\right) \times \frac{Acquirer's\ patents\ in\ common\ subcategories}{Acquirer's\ patents}$$

4.4 Moderating variable

Based on the procedure outlined in Kogut & Singh (1988), cultural distance is calculated using a Euclidean distance measure derived from Hofstede's (2010) national cultural index. Kogut and Singh (1988) defined national cultural distance as the degree of which one country's cultural norm differs from that of the other country. Following Kogut and Singh's (1988) method, cultural differences between acquirers and target firms were calculated using Hofstede's (2010) power distance, uncertainty avoidance, masculinity/femininity, and individualism scores.

4.5 Control variables

Several additional variables were included in the model to control for alternative explanations of the findings. The degree of organizational integration was measured by ownership percentage the acquiring firm claims at each M&A case. As a firm's innovative output may be influenced by its knowledge base, the acquiring firm's size of the knowledge base was also controlled for. Size of the knowledge base was measured by the natural logarithm of the number of patents an acquiring firm had prior to an M&A. Furthermore, the size of M&A transaction was also controlled for, by taking the natural logarithm of a size of the deal. To control for the market similarity between M&A partners, the industry relatedness was measured using four-digit SIC codes of the target and acquiring firms. The value of 1 was given if target and acquiring firms' SIC code matches and the value 0

otherwise (dummy variable). Political distance measures the diplomatic ties between the acquirer and target countries (Berry et. al,. 2010). External trade associations have been found to correlate with the choice of foreign markets to enter, and foreign direct investment flows (Delios & Henisz, 2003; Gastanaga et al., 1998). In this study, whether the acquirer and target countries have a dyadic membership in the same trade bloc has been controlled as political distance. And Research has found that differences in colonial ties, language and religion correlate with occurrence of cross-border mergers and acquisitions, and with the choice of foreign markets to enter (Guler & Guillen, 2010; Lubatkin et al., 1998). This study has controlled the colonial link between acquirer and target as the administrative distance.

5. Result

The hypotheses were tested through OLS regression. Table 2 shows descriptive statistics of all variables included in the model. None of the variance-inflation factor (VIF) of the variables was found to be higher than the threshold of 10, suggesting that multi-collinearity is not a major concern. Table 3 summarizes linear regression estimates of the research model. The statistical analysis of the impact of the technological complementarity on firm's innovation performance is presented in the Model 1. As this research hypothesizes, the results show that the sign of technological complementarity is positive and its coefficient is different significantly from zero (0.499; $p<0.05$). Therefore, hypothesis 1 is supported.

Table 2. Summary statistics and correlation matrix

	Mean	Std. Dev.	1	2	3	4	5	6	7	8
1. Innovation performance	0.617	0.190								
2. Technology complementarity	0.314	0.151	0.4859*							
3. Cultural distance	1.096	1.069	-0.2459*	0.3304*						
4. Degree of integration	0.886	0.227	-0.031	-0.101	-0.139					
5. Deal size	3.926	1.093	0.046	0.047	-0.072	0.059				
6. Acquirer patents base	4.081	1.831	-0.001	-0.012	0.109	-0.037	0.032			
7. Market similarity	0.770	0.422	0.091	-0.012	-0.103	0.055	0.044	0.110		
8. Administrative distance	0.356	0.480	0.053	-0.025	-0.279	0.049	0.077	0.070	0.07	
9. Political distance	0.366	0.483	-0.047	-0.088	-0.078	0.065	-0.046	0.029	-0.023	-0.066

N= 191.

*+p<0.1, *p<0.05, **p<0.01*

In Model 2, interaction terms between technological complementarity and cultural distance was included. The interaction term Technological complementarity x Cultural distance is negative and significant (−0.227; $p<0.05$), providing support for hypothesis 2.

Table 3. Linear regression analysis of firm's innovation performance

Variables	Model 1	Model 2
Main effect		
Technology complementarity (H1)	0.499*	0.807*
	(0.11)	(0.07)
Moderating effect		
Technology complementarity		-0.227*
x Cultural distance (H2)		(0.07)
Control variables		
Cultural distance	-0.159	-0.086
	(0.02)	(0.01)
Degree of integration	-0.023	-0.025
	(0.05)	(0.05)
Deal size	-0.003	-0.001
	(0.01)	(0.00)
Acquirer patents base	0.006	0.005
	(0.01)	(0.01)
Market similarity	0.21	0.024
	(0.03)	(0.02)
Administrative distance	-0.029	-0.034
	(0.02)	(0.02)
Political distance	-0.013	-0.011
	(0.02)	(0.02)
Constant	0.464*	0.547*
	(0.07)	(0.07)
Adj. R^2	0.41	0.44
F	17.42*	17.76*

standard errors in parentheses

*+p<0.1, *p<0.05, **p<0.01;.*

Overall, complementary technology between acquiring and target firms brings positive impact on firm's post-M&A innovation. Following the arguments of previous studies, the findings in this study suggest that the role of cultural distance in cross-border M&As impede the subsequent value creating activities. Cultural distance presents a negative impact on the relationship between technological complementarity and innovation performance in this study.

6. Discussion

6.1 Contribution

Although the effect of technological acquisition on post-merger performance in general has been addressed in a few recent studies (Ahuja & Katila, 2001; Gerpott, 1995; Grandstrand & Sjolander, 1990; Makri et al, 2010), empirical support for technology complementarity is still needed. And very little is known about the interplay between technology complementarity and cultural distance on post-merger innovation performances. In order to fill this research gap, the model presented in this research examines the effects of technological complementarity between merging firms on the innovation performance using 191 cross-border M&A cases. This study explains the ways in which technological complementarity creates value in cross-border M&As. Furthermore, this study investigates whether the cultural distance between merging partners either promotes or impedes knowledge integration process in post-merger. We believe this is an important extension to the existing literature.

Several key findings through the empirical analyses should be mentioned. First, the results support the notion that complementary knowledge between merged partners has a positive effect on firm's post-M&A innovation performance. When a firm acquires a target with complementary resources which can be effectively combined with an existing asset, the firm is more encouraged to build on the existing technological trajectory by expanding its product lines through modified products. Furthermore, due to relatively high absorptive capacity resulted from having common technological field, technological complementarity could escalate the degree of knowledge being assimilated and commercially exploited by the acquiring firm (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998). The results also emphasize the effect of cultural distance on the post-M&A performance. Especially, the research model incorporates both technological complementarity and cultural distance and examines how they are interrelated for the successful post-acquisition performance. While quite a few studies demonstrate the relationship between the relatedness of acquirer's and target's technological knowledge and post-acquisition innovation performance (e.g., Ahuja & Katila, 2001; Cassiman et al., 2005; Hagedoorn & Duysters, 2002; Makri et al., 2010), they fail to take into account the role of knowledge integration in such relationship. Following previous research, the results of this thesis suggest that when high technological complementarity exists between a buyer and a target, high cultural distance hurts the knowledge integration and the subsequent innovation performance. Although high absorptive capacity caused by complementarity expedites knowledge transfer process, problems such as different communication system, low level of shared understanding leading to high integration costs hinder a firm to conduct innovation activity (Puranam et al., 2006).

6.2 Managerial implications

This research casts several practical implications for managers in the field who seek for a potential acquisition target. Managers should take technological complementarity between two merging partners into account if they intend to increase the firm's innovation output after the M&A. As the results of this study suggest, if a buyer seeks to develop innovation through an M&A, it should choose a target with complementary knowledge that can create synergy effect with the existing stock of technology. Likewise, although many firms typically implement due diligence on a target focusing on its financial condition (Hitt, Harrison, & Ireland, 2001), they should assess the target's technological resources before an acquisition. Furthermore, managers should not only consider technological complementarity between a buyer and a target but also the potential factors creating large costs that may arise from organizational integration. Especially in the case of cross-border M&A, managers should keep in mind that acquiring a target firm with distant cultural backgrounds may hinder knowledge integration process and, thus, harm buyer's post-acquisition innovation. Even when a target firm has technology highly complementary with what the acquiring firm possesses, managers should improve communication system inside the organization to promote shared understanding. Therefore, this research suggests that managers consider both the technological complementary and cultural distance between the two firms simultaneously when conducting acquisitions.

6.3 Limitations

Although this thesis has answered several issues arising from the previous

studies on cross-border M&As and technological relatedness, several limitations should be mentioned. First, the applicability of this study may be confined to industries in which firms actively apply for patents. Patents are highly industry specific and that they are not always preferred method of protection against imitation when compared with other methods such as trade secrets (Cohen, Nelson, & Walsh, 2000). Moreover, firms in certain high-technology industries may value tacit knowledge more importantly and pay less attention to patent activities; for those firms, analyzing patent characteristics may not be a relevant way to examine firm's innovation activity.

Second, the sample of acquisitions is fairly small as a limited time window of cross-border technology acquisitions were collected. Due to limited access to recent data, this study may not fully represent most up-to-date phenomenon in cross-border M&As. Future research should examine the latest M&A cases to provide better implications to current practitioners evaluating potential acquisition targets in high-technology industries.

Third, although patents have been used extensively to evaluate firm's innovation activity (Hitt et al., 1991; Pakes & Grilliches, 1980) and generally correlate with new products (Comanor & Scherer, 1969), not all patents or products are commercialized. Therefore, the commercial success of the new acquisition of technology may not be clearly evaluated by merely evaluating the patent characteristics. And patent counts only captures the quantity of innovation, not the quality of innovation.

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국 문 초 록

본 연구는 기술 보완성이 기술 인수 후 혁신 성과에 어떠한 영향을 미치는지를 검토하였다. 보완적인 기술을 인수한다면 인수 후 혁신 성과에 긍정적인 영향을 미칠 것이라고 예측하였다. 또한, 문화적 차이가 기술 이전 및 통합 과정에 영향을 미친다는 연구 결과가 있는 바, 본 연구에서는 문화적 차이는 기술 보완성과 혁신 성과 간의 관계를 조절하는지를 살펴보았다. 1985년부터 1995년 간의 해외 기술 인수 191건으로 데이터 분석한 결과, 문화적 차이가 클수록 기술 보완성과 혁신 성과 간의 긍정적인 관계가 약해진다고 밝혔습니다. 본 연구는 기술 인수를 진행하려는 경영진에게 기술 보완성과 문화적 차이를 고려해야 된다는 시사점을 줄 수 있다.

주요어: 기술 보완성, 혁신 성과, 기술 인수, 문화적 차이, 해외 인수

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